RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIFTH SEMESTER EXAMINATION, MARCH 2022

THIRD YEAR [BATCH 2019-22]

Date : 03/03/2022

MICROBIOLOGY (HONOURS)

Time : 11 am – 1 pm

Paper : DSE 1

Full Marks : 50

1. Answer **any five** questions of the following: [5×10]

   a) A male mouse from a true-breeding strain of hyperactive animals is crossed with a female mouse from a true-breeding strain of lethargic animals. (These are both hypothetical strains.) All the progeny are lethargic. In the F2 generation, all offspring are lethargic. What is the best genetic explanation for these observations? Propose a cross to test your explanation.

   b) A wildflower native to California, the dwarf lupin (*Lupinusnanus*) normally bears blue flowers. Occasionally, plants with pink flowers are observed in wild populations. Flower color is controlled at a single locus, with the pink allele completely recessive to the blue allele. Harding (1970) censused several lupin populations in the California Coast Ranges. In one population of lupins at Spanish Flat, California, he found 25 pink flowers and 3291 blue flowers, for a total of 3316 flowers. Calculate the expected allele frequencies and genotype frequencies if the population were in Hardy-Weinberg equilibrium.

   c) On cytological examination of squamous epithelial cells from buccal cavity of a human male showed the presence of a Barr body but without any evidence of Kleinefelter syndrome. How can you proceed to find out the actual cause of this anomaly?

   d) In higher organisms a single gene may control more than one phenotypic trait. How can you determine whether the traits are controlled by same gene pair or different gene pairs together?

(3+3+2+2)

2. a) You are analysing the genetic composion of each of the eight ascospores contained in the asci of *Neurospora crassa* with respect to two parental hypothetical allele pairs m_1m_2+ and $m_1^+m_2$. For majority of the asci showed the normal allelic ratio for each ascus m_2+ $m_{2=}$ 4:4 and $m_1^+m_{1=}$ 4:4 *but* a few asci showed deviations where m_2+ $m_{2=}$ 6:2 or 5:3. How can you explain these results?

   b) Cooke and Ryder (1971) studied the nestlings of Ross's goose, a small Arctic nesting goose. Goslings (baby geese) exist in two color morphs, grey or yellow. Cooke and Ryder reported that a population of geese at Karrack Lake, Canada included 263 yellow goslings and 413 grey goslings (676 total). They assumed that color is controlled by two alleles at a single locus. Calculate the frequencies of all three possible genotypes, assuming that grey are dominant and that the population is in Hardy-Weinberg equilibrium. Then repeat, assuming that yellow is dominant.

c) Out of the two members of a couple the female with blood type "BO" exhibited the autosomal dominant disorder, nail-patella syndrome. Her husband was had blood type "OO" but without this syndrome.

The birth sequence of their twelve (12) children is as follows—

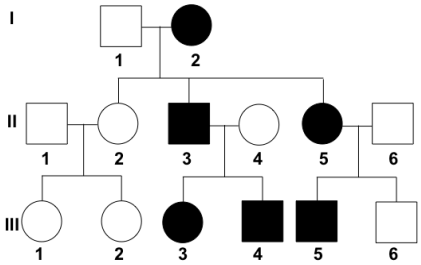
Birth sequence	Blood Type	Nail-patella syndrome ["+" present "-" absent]
Daughter	BO	+
Son	BO	+
Son	BO	-
Son	OO	+
Daughter	OO	-
Daughter	BO	+
Son	OO	-
Daughter	BO	+
Daughter	BO	+
Son	OO	-
Daughter	OO	+
Son	BO	+

Show whether nail-patella syndrome is associated with blood typing or not. (3+3+4)

3. a) A maternal effect gene in *Drosophila*, called *torso*, is found as a recessive allele that prevents the correct development of anterior- and posterior-most structures. A wild-type male is crossed to a female of unknown genotype. This mating produces 100% larva that are missing their anterior- and posterior-most structures and therefore die during early development. What is the genotype and phenotype of the female fly in this cross? What are the genotypes and phenotypes of the female fly's parents?

b) Fights between hawks are brutal affairs with the loser being the one who first sustains injury. The winner takes sole possession of the resource - Explain this with the help of game theory (Hawk-Dove model).

c)



The above pedigree represents a human genetic disorder inherited by means of autosome. The symbol for the wild and mutant (disease) genes are denoted as d^+ and d respectively.

State whether the disorder is dominant or recessive.

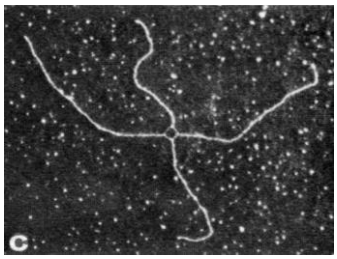
Construct the genotypes for each of the members in the pedigree.

d) Humans like many other animals and plants originate from the division and differentiation of the very single-celled zygote resulted from fertilization. Though genotypically all the cells of the body are identical but different in respect of phenotype. How are these achieved? (3+2+3+2)

4. a) Differentiate between multigenic and multiple allelic inheritance with suitable examples you have studied.

   b) The line between 'micro' and 'macro' is mostly arbitrary and depends on the individual's definition – Explain this under the shed of different evolutionary theories.

   c) How can you explain the electron micrographic structure shown below formed during homologous recombination? State the subsequent fate of this structure.

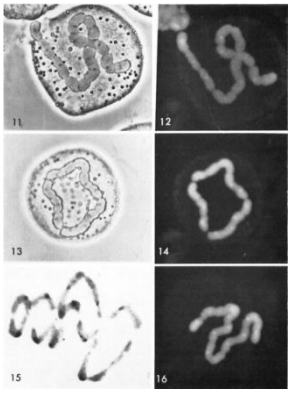


   d) Mention a very commonly used molecular biological technique where using a fluorescent dye the location of any kind of base sequence/gene on any chromosome can be known. (3+2+3+2)

5. a) Can you design an *in vitro* experiment with animal cell by which you can directly infer that the gene for any phenotypic trait you are investigating is located outside the nucleus?

   b) Hardy-Wienberg law is applicable to find out the genotype for any phenotypic traits– Justify with an example.

   c) The photomicrograph shown below represents the diakinesis stage of meiosis I of pollen mother cells of *Rhoeo discolor* (2n=12) .Instead of forming six bivalents why are the chromosomes remain held in chains?



   d) Mention the steps followed in QTL mapping of genes governing quantitative traits. (2+3+3+2)

6. a) In a cross of *Limnaea*, the snail contributing the eggs was dextral but of unknown genotype. Both the genotype and the phenotype of the other snail are unknown. All F_1 offspring exhibited dextral coiling. Ten of the F_1 snails were allowed to undergo self-fertilization. One-half produced only dextrally coiled offspring, whereas the other half produced only sinistrally coiled offspring. What were the genotypes of the original parents?

b) In a study of the Hopi, a Native American tribe of central Arizona, [Woolf and Dukepoo, 1959] found 26 albino individuals in a total population of 6000. This form of albinism is controlled by a single gene with two alleles: albinism is recessive to normal skin coloration. Can you calculate the allele frequencies from this information? Justify your answer. Calculate the expected allele frequencies and genotype frequencies if the population were in Hardy-Weinberg equilibrium. How many of the Hopi are estimated to be carriers of the recessive albino allele?

c) What should be the genotypic ratio in the children if their parents are both having "AB"blood typing?

How can the usual phenotypic ratio be changed to A: B: AB: O=3:6:3:4 in spite of neither of the parents have "O" allele? [2+(1+2+1)+4]

7. a) An individual with Angelman syndrome produced an offspring with Prader-Willi syndrome. Why does this occur? What are the sexes of the parent with Angelman syndrome and the offspring with Prader-Willi syndrome?

b) The "TIGON" in Alipur zoo was created following mating between tiger and lion which indicate close genetic relationship between these two big cats and originated from a common ancestor. Propose the natural mechanisms by which these big cats of two different species may originate from a common ancestor.

c) What is amphidiploid and how is it induced? State its importance in plant breeding with suitable example.

d) Under which condition the phenotypic ratio in a dihybrid experiment be changed to 1:2:1:2:4:2:1:2:1 instead of usual 9:3:3:1 ratio? (2+2+4+2)

8. a) State the mechanistic differences between the homologuous and site specific recombination.

b) What is non–disjunction? How can this natural process be utilized to prove that "Y"-chromosome in *Drosophila* does not have any role in sex determination?

c) Which genes in the animals are associated with formation of fundamental body patterns? Cite proper examples in *Drosophila* and humans with associated genes.

d) In prokaryotes the genes associated with many metabolic functions remain organised in an operon. Which state of genes present in eukaryotes are equivalent to an operon. Propose the mechanisms of their generations. (2+3+3+2)

9. a) What conclusions can you draw about the relationship between the way in which the present-day theory of molecular evolution developed and the credibility of the theory? Explain your thinking with proper examples.

b) The backcross method is utilized to incorporate a desired gene to a local cultivated crops. How can it be done?

c) Which characteristics of mitochondria indicate its early origin from an endosymbiotic bacteria?

d) Presence of a mutant gene may not be expressed as phenotype always. How are these situations explained in the context of genetics? (2+3+3+2)

10. a) What is meant by "position effect" in the functioning of a gene? This method may play an important role in evolution. How?

b) How can you prove genetically the existence of maternal effect genes in *Drosophila*? How are the functions of maternal effect genes differ from zygotic genes?

c) During investigation to find out the number of genes associated with a quantitative trait, say height of humans, it has been seen that the number of extreme "tall" phenotype is four out of 1024 progeny scored. How many genes may be associated with this trait? (4+4+2)

———— × ————